Amendments to the Claims

This listing of claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims

Claim 1. (Original) A process for partially oxidizing propene to acrylic acid in the gas phase under heterogeneous catalysis by conducting a starting reaction gas mixture 1 which comprises propene, molecular oxygen and at least one inert gas, and contains the molecular oxygen and the propene in a molar O_2:C_3H_6 ratio of ≥ 1 in a first reaction stage over a fixed catalyst bed 1 which is arranged in two spatially successive reaction zones A, B, the temperature of reaction zone A being a temperature in the range from 290 to 380° C and the temperature of reaction zone B likewise being a temperature in the range from 290 to 380° C, and whose active composition is at least one multimetal oxide comprising the elements Mo, Fe and Bi, in such a way that reaction zone A extends to a propene conversion of from 40 to 80 mol % and the propene conversion on single pass through the fixed catalyst bed 1 is $\geq$ 90 mol % and the accompanying selectivity of acrolein formation and also of acrylic acid by-production taken together is $\geq$ 90 mol %, the temperature of the product gas mixture leaving the first reaction stage is optionally reduced by cooling and molecular oxygen and/or inert gas are optionally added to the product gas mixture, and then the product gas mixture, as a starting reaction gas mixture 2 comprising acrolein, molecular oxygen and at least one inert gas and containing the molecular oxygen and the acrolein in a molar O_2:C_3H_4O ratio of ≥ 0.5, is conducted in a second reaction stage over a fixed catalyst bed 2 which is arranged in two spatially successive reaction zones C, D, the temperature of reaction zone C being a temperature in the range from 230 to 320° C and the temperature of

reaction zone D likewise being a temperature in the range from 230 to 320° C, and whose active composition is at least one multimetal oxide comprising the elements Mo and V, in such a way that reaction zone C extends to an acrolein conversion of from 45 to 85 mol % and the acrolein conversion on single pass through the fixed catalyst bed 2 is ≥ 90 mol % and the selectivity of acrylic acid formation assessed over all reaction zones, based on converted propene, is ≥ 80 mol %, the sequence in time in which the reaction gas mixture flows through the reaction zones corresponding to the alphabetic sequence of the reaction zones, wherein

a) the hourly space velocity of the propene contained in the starting reaction gas mixture 1 on the fixed catalyst bed 1 is < 160 l (STP) of propene/l of fixed catalyst bed 1 ∘ h and ≥ 90 l (STP) of propene/l of fixed catalyst bed 1 ∘ h;

b) the volume-specific activity of the fixed catalyst bed 1 is either constant or increases at least once in the flow direction of the reaction gas mixture over the fixed bed catalyst bed 1;

c) the difference $T^{maxA} - T^{maxB}$, formed from the highest temperature T^{maxA} which the reaction gas mixture has within reaction zone A and the highest temperature T^{maxB} which the reaction gas mixture has within reaction zone B is ≥0° C;

d) the hourly space velocity of the acrolein contained in the starting reaction gas mixture 2 on the fixed catalyst bed 2 is < 145 l (STP) of acrolein/l of fixed catalyst bed 2 ∘ h and ≥ 70 l (STP) of acrolein/l of fixed catalyst bed 2 ∘ h;

e) the volume-specific activity of the fixed catalyst bed 2 increases at least once in the flow direction of the reaction gas mixture over the fixed bed catalyst bed 2; and

f) the difference $T^{maxC} - T^{maxD}$, formed from the highest temperature T^{maxC} which the reaction gas mixture has within reaction zone C and the highest temperature T^{maxD} which the reaction gas mixture has within reaction zone D, is $\geq 0°$ C.

Claim 2. (Original) A process as claimed in claim 1, wherein the difference $T^{maxA} - T^{maxB}$ is $\geq 3°$ C and $\leq 70°$ C.

Claim 3. (Original) A process as claimed in claim 1, wherein the difference $T^{maxA} - T^{maxB}$ is $\geq 20°$ C and $\leq 60°$ C.

Claim 4. (Currently Amended) A process as claimed in ~~any of claims~~ claim1 ~~to 3~~, wherein the difference $T^{maxC} - T^{maxD}$ is $\geq 3°$ C and $\leq 60°$ C.

Claim 5. (Currently Amended) A process as claimed in ~~any of claims~~ claim1 ~~to 3~~, wherein the difference $T^{maxC} - T^{maxD}$ is $\geq 3°$ C and $\leq 40°$ C.

Claim 6. (Currently Amended) A process as claimed in ~~any of claims~~ claim 1 ~~to 5~~, wherein the hourly space velocity of the propene contained in the starting gas mixture on the fixed catalyst bed 1 is ≥ 100 l (STP) or propene/l • h and ≤ 150 l (STP) or propene/l·h.

Claim 7. (Currently Amended) A process as claimed in ~~any of claims~~ claim 1 ~~to 5~~, wherein the hourly space velocity of the propene contained in the starting gas mixture on the fixed catalyst bed 1 is ≥110 l (STP) or propene/l • h and ≤ 145 l (STP) or propene/l·h.

Claim 8. (Currently Amended) A process as claimed in ~~any of claims~~ claim 1 ~~to 7~~, wherein the difference $T_B - T_A$ between the temperature of reaction zone B, T_B, and the temperature of reaction zone A, T_A, is ≥-10° C and ≤0° C.

Claim 9. (Currently Amended) A process as claimed in ~~any of claims~~ claim 1 ~~to 8~~, wherein the difference $T_C - T_D$ between the temperature of reaction zone D, T_D, and the temperature of reaction zone C, T_C, is ≥-10° C and ≤0° C.

Claim 10. (Currently Amended) A process as claimed in ~~any of claims~~ claim 1 ~~to 9~~, wherein the temperature of reaction zone A is from 305 to 365° C.

Claim 11. (Currently Amended) A process as claimed in ~~any of claims~~ claim 1 ~~to 9~~, wherein the temperature of reaction zone A is from 310 to 340° C.

Claim 12. (Currently Amended) A process as claimed in ~~any of claims~~ claim 1 ~~to 11~~, wherein the temperature of reaction zone C is from 250 to 300° C.

Claim 13. (Currently Amended) A process as claimed in ~~any of claims~~ claim 1 ~~to 12~~, wherein the temperature of reaction zone C is from 260 to 280° C.

Claim 14. (Currently Amended) A process as claimed in ~~any of claims~~ claim 1 ~~to 13~~, wherein the active composition of the fixed catalyst bed 1 is at least one multimetal oxide active composition of the general formula I

$$Mo_{12}Bi_aFe_bX^1{}_cX^2{}_dX^3{}_eX^4{}_fO_n \quad (I)$$

where

X^1 = nickel and/or cobalt,

X^2 = thallium, an alkali metal and/or an alkaline earth metal,

X^3 = zinc, phosphorus, arsenic, boron, antimony, tin, cerium, lead and/or tungsten,

X^4 = silicon, aluminum, titanium and/or zirconium,

a = from 0.5 to 5,

b = from 0.01 to 5,

c = from 0 to 10,

d = from 0 to 2,

e = from 0 to 8,

f = from 0 to 10 and

n = a number which is determined by the valency and frequency of the elements other than oxygen in I.

Claim 15. (Currently Amended) A process as claimed in ~~any of claims~~ claim 1 ~~to 14~~, wherein the active composition of the fixed catalyst bed 2 is at least one multimetal oxide active composition of the general formula IV

$$Mo_{12}V_aX^1{}_bX^2{}_cX^3{}_dX^4{}_eX^5{}_fX^6{}_gO_n \qquad (IV)$$

where the variables are defined as follows:

X^1 = W, Nb, Ta, Cr and/or Ce,

X^2 = Cu, Ni, Co, Fe, Mn and/or Zn,

X^3 = Sb and/or Bi,

X^4 = one or more alkali metals,

X^5 = one or more alkaline earth metals,

X^6 = Si, Al, Ti and/or Zr,

a = from 1 to 6,

b = from 0.2 to 4,

c = from 0.5 to 18,

d = from 0 to 40,

e = from 0 to 2,

f = from 0 to 4,

g = from 0 to 40 and

n = a number which is determined by the valency and frequency of the elements other than oxygen in IV.